BRIEF REPORTS

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Absolute intensity of internal bremsstrahlung from the electron capture decay of ^{125}I

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The absolute intensity of the internal bremsstrahlung spectrum accompanying the electron capture decay of ^{125}I has been measured and compared to the recent calculation of Surić *et al.* The measured intensity above the $1s$ end point is found to be $(86 \pm 10)\%$ of the calculated intensity.

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In 1981 De Rújula [1] suggested that the end-point shape of the internal bremsstrahlung (IB) spectrum which accompanies electron capture decay (IBEC) might be sensitive to the mass of the neutrino. The sensitivity is obtained for decays with end-point energies that are (a) small, and (b) close to an x-ray transition energy. De Rújula's suggestion spurred searches for an investigation of IBEC decays with low Q values, where the IB spectrum is dominated by capture from p orbitals. A group at CERN [2] carried out detailed measurements on the IBEC decay of ^{193}Pt to test the theoretical calculations of De Rújula. Although the calculations reproduced the measured shapes of the IB spectra, the magnitudes were off by factors of 1.5 to 2. Recently, Surić, Horvat, and Pisk [3] developed a code to calculate IBEC matrix elements in an independent-particle approximation, with atomic wave functions obtained from a relativistic self-consistent-field potential. Their calculated spectrum for ^{193}Pt was also lower than the data by about a factor of 2. There are very few other accurate measurements of the absolute intensity of low-Q-value IB spectra which could be used to test the theoretical calculations. The recent use of IB spectra to search for the 17 keV neutrino [4–9], and to establish accurate EC decay Q values [4] highlights the need for further tests of the IBEC theory, especially for decays with low Q values.

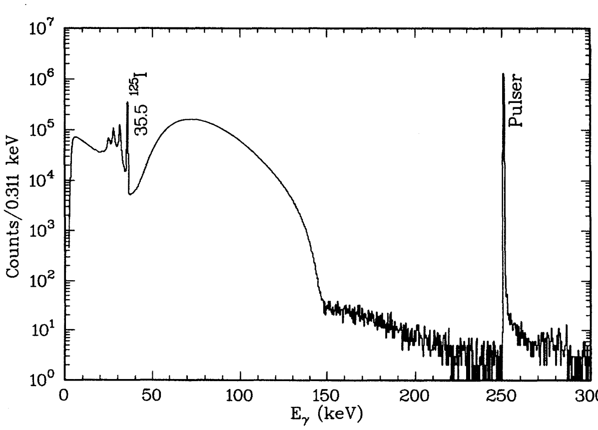

FIG. 1. A 12 hour raw spectrum of the ^{125}I source recorded in a planar Ge detector.

During the course of our experiment to search for 17 keV neutrinos in the IB spectrum of ^{125}I [4] we obtained absolutely calibrated IB spectra; however, because of the large difference in the x-ray count rate from the ^{125}I source (~ 100 mCi) and from available calibration sources ($\sim$ a few μCi), we were unable to (easily) calibrate the ^{125}I source strength and hence to give the absolute intensity of the IB spectrum. Several half-lives have now elapsed since the completion of the IB measurement and the source strength has become sufficiently low to allow an absolute calibration. We present in this Brief Report the absolutely calibrated IB spectrum and compare the intensity to the theoretical calculation of Surić *et al.* [3].

To determine the source activity, the yield of Te K x rays and of the 35.5-keV γ ray from the decay of the ^{125}Te^m isomer were measured using a planar Ge detector with no absorbers and with the source at a distance of 16.5 cm from the detector. The intensities of the $K\alpha$, $K\beta$, and 35.5-keV lines were taken respectively as 1.135 ± 0.021, 0.255 ± 0.006, and 0.0658 ± 0.0008 per decay [10]. The absolute efficiency of the detector as a function of energy was obtained from calibrated ^{57}Co, ^{109}Cd, and ^{133}Ba point sources. The resulting activity of the source, at the time of calibration, was thus found to be 125 ± 8 μCi.

Figure 1 shows the raw ^{125}I IB spectrum used for determining the absolute IB yield. The spectrum was obtained during our experiment to search for 17 keV neutrinos; the setup and procedures are described in detail in Ref. [4]. The spectrum was collected over a period of 12 hours. The source strength at the time of collection was 78.4 ± 5.0 mCi.[1] The half-life used in determining the source activity at the time of the IB measurement was 59.43 ± 0.06 d [10]. A precision 60.0 Hz pulser was used to correct for dead time and pileup losses. The relative efficiency of the detector as a function of

[1]The deduced strength of the source at the time of purchase is 208 ± 13 mCi; this confirms the manufacturer's (Amersham Corporation) nominal value of 200 mCi.

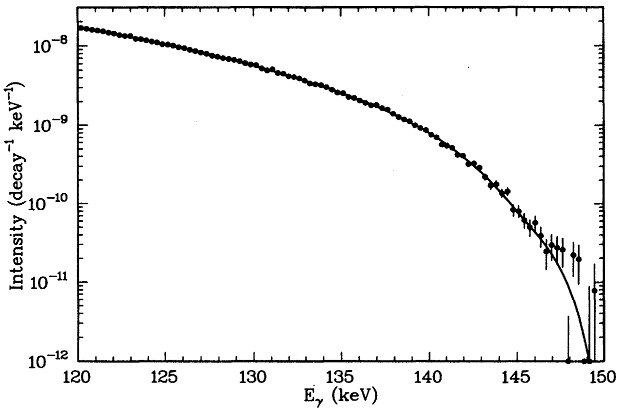

FIG. 2. Net IB spectrum of ^{125}I above the $1s$ end point. The solid line is a normalized fit using the Surić *et al.* calculation. The (multiplicative) normalization factor for the theoretical calculation is 0.86 ± 0.10.

energy for the IB measurement was determined with a ^{182}Ta source. The absolute efficiency at 122.034 keV was determined from a calibrated ^{57}Co source. The contributions of pileup, background, and contaminants were subtracted in the same manner as described previously in Ref. [4].

Figure 2 shows the absolutely normalized net IB spectrum together with a fit using Surić *et al.*'s calculation [3] (convoluted with the response function of the detector). The lowest energy used in the fit is 120 keV, which is above the 118.4-keV end point of the $1s$ IB component. The theoretical calculation was multiplied by a fitted normalization parameter. The fitted value was 0.857 ± 0.003, where the error is statistical only. We estimate the uncertainty in the absolute efficiency calibration of the IB spectrum to be $\pm 10\%$, arising mainly from the uncertainty in the position of the ^{125}I source relative to the position of the calibration source. We combine this uncertainty in quadrature with the 6.4% uncertainty in the ^{125}I source strength to obtain 0.86 ± 0.10 for the normalization parameter.

In our previous work [4] we indicated that the Surić *et al.* calculation [3] reproduces the shape and relative intensity of the partial IB spectra for ^{125}I to within a few percent. The above normalization factor indicates that the Surić calculation essentially reproduces (to within 15%) the absolute intensity of the IB spectrum, as well. This is in contrast to the result for ^{193}Pt, where the Surić calculation underestimates the experiment by about a factor of 2. Because of the paucity of accurate absolute p IB measurements, it is not clear whether the agreement with our data is fortuitous, or whether there is a systematic divergence between theory and experiment as a function of the atomic number. Clearly more systematics are needed before a firm conclusion can be reached.

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